Fall 2021

Effects of Soil Pollution on Human Health

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CHE 141- 405H

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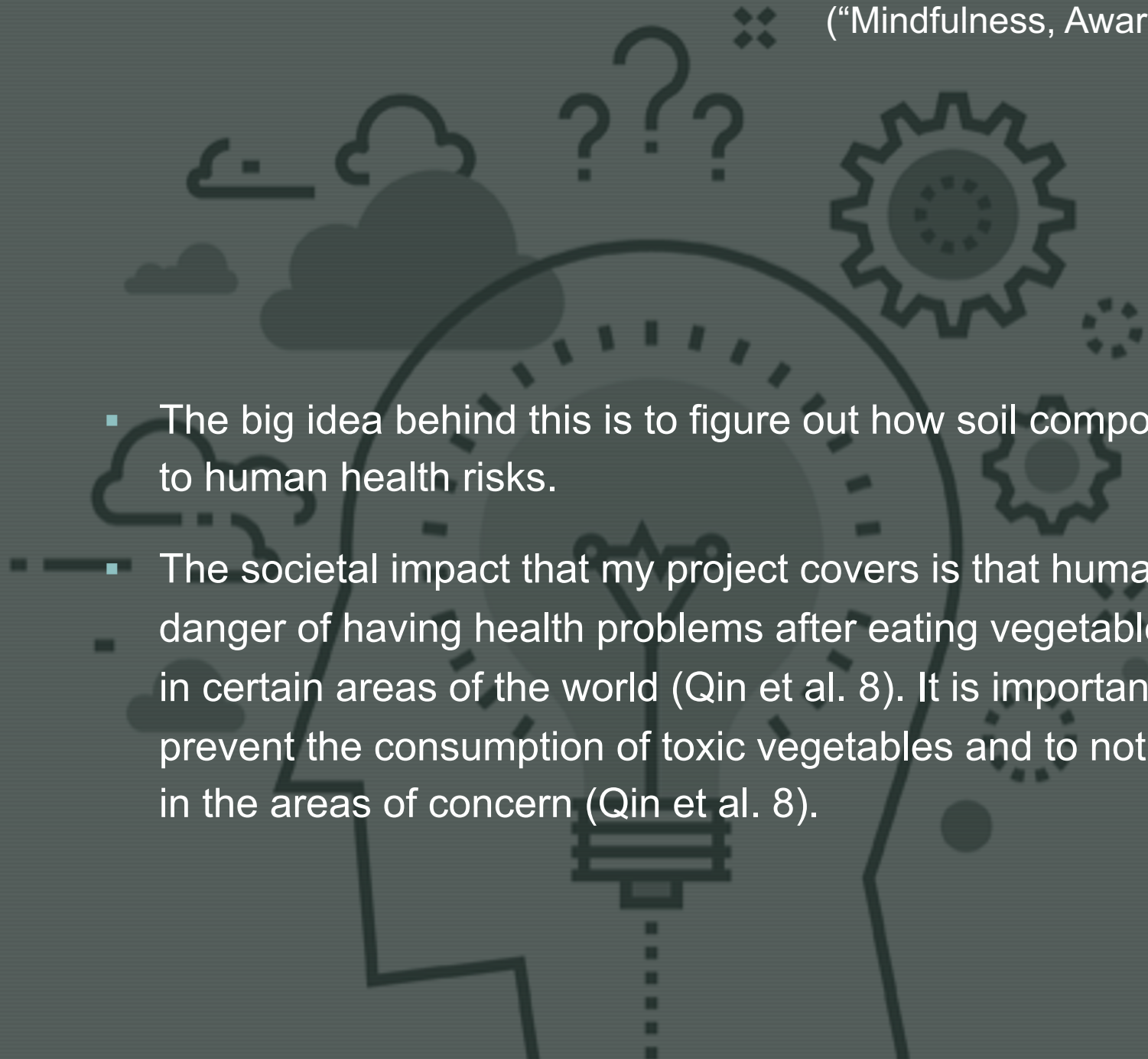
Big Picture

- For the Research Project, my topic is to observe the effects of soil pollution linked to human health issues.

Audience

- I decided to pick this health-related topic because I hope to go into the medical field, specifically dentistry. From this research, I hope to gain knowledge about soil components and apply it to my interested in human health.
- People that would be interested in my topic include anyone wanting to study something related to the medical field. I think this topic will pull these people in and they might learn something that relates to their future goals.

(“Mindfulness, Awareness and Pastoral Support”)



- The big idea behind this is to figure out how soil components lead to human health risks.
- The societal impact that my project covers is that humans are in danger of having health problems after eating vegetables grown in certain areas of the world (Qin et al. 8). It is important to prevent the consumption of toxic vegetables and to notify people in the areas of concern (Qin et al. 8).

System Description

- For my research project, I got both of my samples from my hometown located about 2 hours away from Champaign, IL: one sample was from my back yard and the other was from the field behind my house.
  - I decided to look at the organic matter present in my soil samples, as well as the soil texture.
- For my literary research, I decided to pick a topic related to health issues caused by the consumption of toxic leafy vegetables (Qin et al. 2).
- Although, my soil experiment and my research article aren't the same, I thought it would be interesting to see how the effects of soil pollution effect human health.

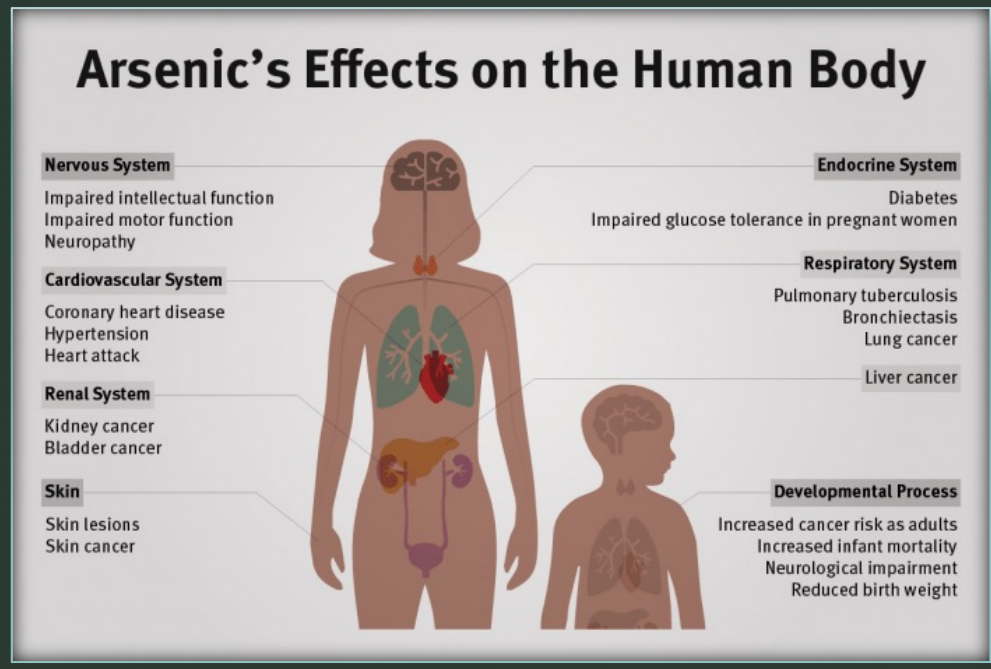
(Saklaine)

Important Terms

- Arsenic (As):

A solid chemical that is highly toxic when in its inorganic form (“Arsenic” 1). It is present in drinking water and food in some areas of the world (“Arsenic” 1). After a long period of time, it can cause cancer and skin abrasions (“Arsenic” 1).

(“The Politics of Arsenic-Free Water”)



Important Terms

("What Is Biochar?")

- <u>Biochar:</u>

A black carbon produced from sources like wood chips, manure, and plant debris, as shown in the picture to the left ("Biochar"). Its purpose is to transform biomass carbon into a more stable form which is known as carbon sequestration ("Biochar"). This is a process that is know for removing carbon dioxide and to help with climate change ("Biochar").

Primary Research Article:

- The experimental question for my primary research article is if the consumption of leafy vegetables grown in soil-borne As has any human health risks (Qin et al 2).
- They also conducted an experiment regarding the effects of biochar on certain leafy vegetables (Qin et al 2).

(Whitworth)

- This study took place in southern China at the Guangdong Dabaoshan Mine, shown in the picture presented, where they collected 16 different leafy vegetables (Qin et al. 2). Arsenate was found to be the main As species within the vegetable soils, entering through the roots (Qin et al. 6).

Results

- They came to the the conclusion that consuming these leafy vegetables, in that area, does indeed show a high risk to human health (Qin et al. 8).
- Biochar helped with plant growth shown by the increase in the plant's biomass (Qin et al. 8).
- I think they should wait a few years to do a follow up since this experiment was recent.

Experimental Research

- My samples include soil from my backyard at home and soil from a field behind my house. I knew I had to pick an area with the same soil composition but different areas. I needed an area that would show similarities and differences within the soil components.

“Photos Taken By Jaylen Haynes”

Experimental Research

- My experimental question was: How do these two samples differ in soil texture and organic matter?
- I thought that when comparing the two samples, my Field sample would show more nutrients and higher overall results.

Experimental Research Results:

- Cotton Test
- K Analysis
- Microbial Activity
- P Analysis
- pH and Conductivity
- POXC
- Sieving
- Slake Test
- Soil Texture

Cotton Test

- From this lab, I found discoloration on both of my cotton samples after about a month and a half of being in a dark location.
- One difference that I found while observing the cotton samples was that my Yard sample had yellow dots, whereas my Field sample had orange dots. I wasn't able to figure out why they had different discolorations, but I thought it was something to note.
- Both cotton samples did not tear when testing the elasticity.

K Analysis

- This lab shows that the health of both of my soil samples requires starter fertilizer. The nutrients is more than adequate, and no more nutrients are needed. Both soil samples were above optimum level and on the higher end.

Soil Type	Ppm Results	Lb/acre Results
Yard	28.2 ppm	578 lb/acre
Field	36.5 ppm	730 lb/acre

Microbial Titration Activity

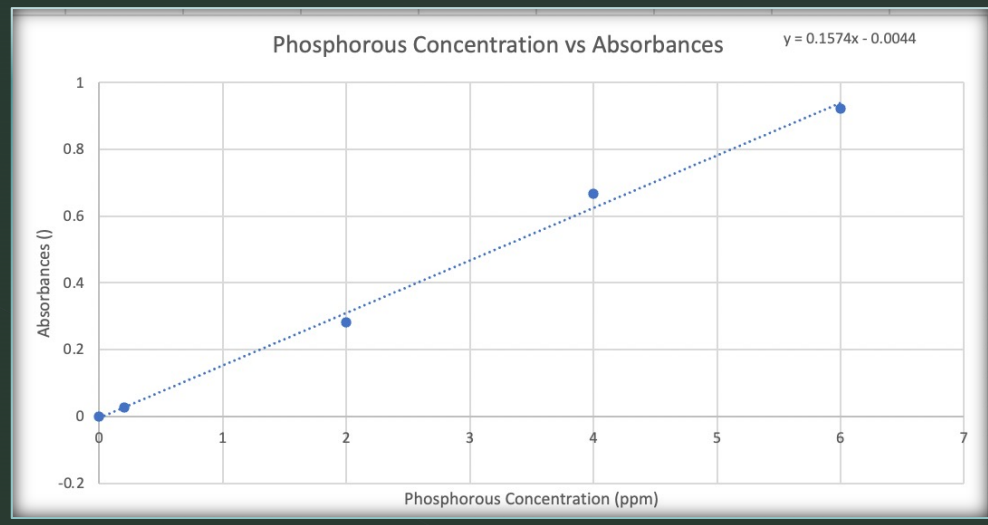
Soil Type	**Amount of CO_2 Produced by Soil Microbes (moles CO_2)**	**Average Molarity of the NaOH in the Supernatant (M)**	**Overall Microbial Activity (mg CO_2 / kg soil × day)**
Yard	-0.002361 moles CO_2	0.9100 M	-49.5 (mg CO_2 / kg soil × day)
Field	Insufficient Data	Insufficient Data	Insufficient Data

From this lab, I was able to conclude my Yard sample Microbial Activity. From the chart, there are obvious errors that occurred during the lab procedure that caused my numbers to be very low and not accurate. For my Field sample, I couldn't make any conclusions because of an obvious error. I would have to re-do this lab to get clearer results.

P Analysis

From this lab, we were able to pull phosphorous from our samples to conclude the level of phosphorous concentrations in each sample. Based on my results, both soil samples phosphorous concentrations are very high, meaning, they do not need any fertilization with P_2O_5.

"Screenshot of Graph Produced by Jaylen Haynes"



Soil Type	Ppm Results	Lb/acre Results
Yard	39.58 ppm	79.16 lb/acre
Field	79.29 ppm	158.58 lb/acre

pH and Conductivity

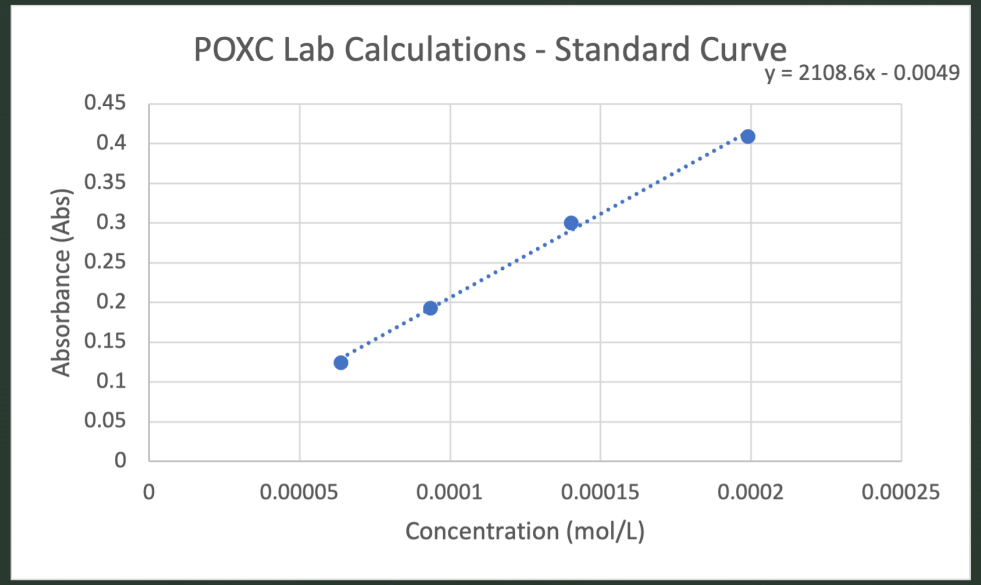
- In this lab, I was able to conclude that both, Yard and Field samples, provide available nutrients for plant growth. My conductivity results are about the same, meaning that there isn't much difference in the available nutrients. Typically, the higher the electrical charge, the more nutrients available.

Soil Type	pH Results (pH)	Conductivity Results (µS)
Yard	7.62 pH	280 µS
Field	7.60 pH	240 µS

POXC

Sample Type	Absorbance Value (Abs)	POXC Value (mg RC/kg soil)
Yard	0.212 Abs	729 mg RC/kg soil
Field	0.137 Abs	944 mg RC/kg soil

The outcome from this lab shows that my Field sample had a lower absorbance value but a higher POXC value, whereas my Yard sample had a higher absorbance value and a lower POXC value. My data points match closely to my line.



"Screenshot of Graph Produced by Jaylen Haynes"

Sieving

- Field Sample:
  - <2mm: light brown with tiny leaves and very dry
  - 2-6.4mm: light brown with some small sticks and very dry
  - >6.4mm: hard to break up, light brown, and no sticks or leaves found

  Yard Sample:
  - <2mm. light brown to grey color with a few grass clippings
  - 2-6.4mm: light brown with a few grass clippings and some small pebbles present
  - >6.4mm: light brown with bigger pebbles present and many roots found

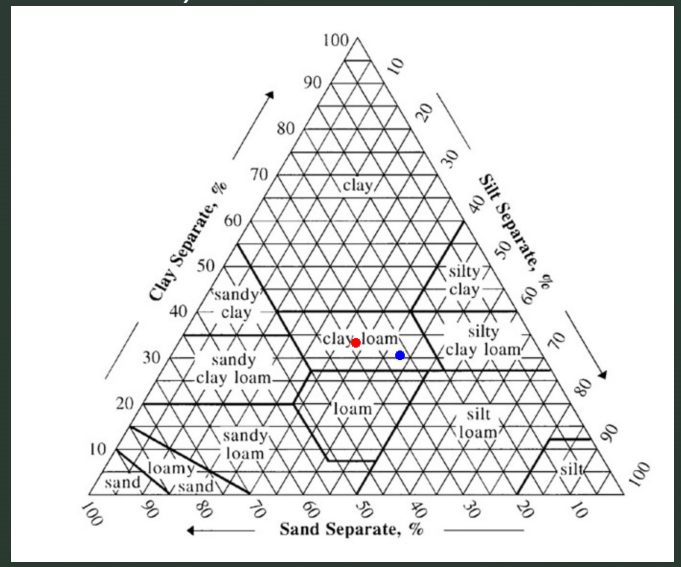
Slake Test

- For this test, my Field sample took longer to absorb the water; meaning there was less fragments at the bottom of my cup.
- My Yard sample absorbed the water much faster causing more fragmentation at the bottom.
- These results show that my Field sample is more nutrient dense than my Yard sample.

Soil Texture

Sample Type	% Clay	% Silt	% Sand	Overall Soil Texture
Yard	32.7%	35.6%	34.7%	Clay Loam
Field	29.8%	42.2%	28.0%	Clay Loam

("Natural Resources Conservation Service.")



The outcome from this lab shows that both of my samples are in the clay loam region of the pyramid. This means that the only difference between the two is the land management.

My Results vs. My Classmates Results

Tests Performed	Soil Texture	pH (pH) Conductivity (µS)	POXC (mg RC / kg soil)	K Analysis	P Analysis	Microbial Activity (mg CO_2 / kg soil × day)
Class Results for Yard Category	Clay loam (Student's garden)	8.17 pH (Student's backyard lawn) 306 µS (Student's garden soil)	601 mg RC / kg soil (Student's Frontyard)	535 lb/acre (Student's garden soil)	57.4 lb/acre (Student's lawn)	54.6 mg CO_2 / kg soil × day (Student's Backyard Garden)
Class Results for Field Category	Clay loam (Student's "weedy" field next to corn)	7.65 pH (Student's corn field) 162.9 µS (Student's corn field)	670 mg RC / kg soil (Student's sweet corn)	653 lb/acre (Student's sweet corn)	54 lb/acre (Student's sweet corn)	35.4 mg CO_2 / kg soil × day (Student's sweet corn)

(Comparison data is based on a document we filled in as a class.)

My Results vs. My Classmates Results

- From the class results, I can conclude that my soil texture was very similar to many of my classmates' results with clay loam as the overall result. My pH results were very similar for both samples compared to the rest of the class. I noticed with my conductivity that my results were in the middle compared to others, but based on the locations that were like mine, my results for my Yard sample were low and my Field sample was higher.
- My POXC results were a lot higher than my classmates with similar locations. My P Analysis results surprised me; they were very high based on others. As far as my K Analysis results, they were right around the others in my section. For Microbial Activity, I couldn't accurately compare my results because of an error during lab and there might have been an error in the control data.

Conclusions

- Initially, I thought that my Field sample would be healthier and have more diverse properties; I was correct with my hypothesis.
- I can conclude that both of my samples are a part of the clay loam region of the pyramid. My Field sample had a higher concentration of phosphorus than my Yard sample.
- I can also conclude that my Field sample has a higher electrical current, and a more neutral pH meaning more nutrients available. My Yard sample has a more acidic pH meaning lower nutrients and has a lower conductivity.
- Based on all my results throughout the semester, I can conclude that the differences between my two samples is based on soil management. The Field sample is fertilized annually and monitored by my grandpa. The Yard sample does not receive annual feralization and is not monitored by anyone. Rain is the only water supply these samples both get.

Error Analysis

- Problems and Solutions:
  - HCl Overload
    - Problem: During the Microbial Titration Lab, there was an obvious error when mixing the HCl with my solution. When the color changed, I added way more to the solution rather than stopping the stopcock.
    - Solution: In order to get a clear and more sufficient result, I would have to re-do the lab to get accurate results.

Future Direction:

How would you follow-up on your results?

I would want to test other parts of the field and areas around the sample I took from my yard. I would want to compare the two new samples with my old ones to see if results are similar and where there are differences.

What questions resulted from your analysis?

- How much of a difference would it make if I took my sample from my front yard rather than my back yard?
- Would it make a difference if I went further into the field to collect my sample?

Works Cited Articles

- "Arsenic." *World Health Organization*, World Health Organization, 15 February 2018 https://www.who.int/news-room/fact-sheets/detail/arsenic.
- "Biochar." *USDA Ars*, 3 March 2020. https://www.ars.usda.gov/midwest-area/stpaul/swmr/people/kurt-spokas/biochar/ .
- Qin, Junhao, et al. "Arsenic in Leafy Vegetable Plants Grown on Mine Water-Contaminated Soils: Uptake, Human Health Risk and Remedial Effects of Biochar." *Journal of Hazardous Materials*, Elsevier, 16 July 2020, https://reader.elsevier.com/reader/sd/pii/S0304389420314758?token=A663F635784C3EC8CC1AD8FB5A2216C34696E42B96DA5BEDAB448AD42CD14654596E3AE2C21BB0338A90187D57004AAE&originRegion=us-east-1&originCreation=20211003153639.

Works Cited Images

- "The Politics of Arsenic-Free Water." *Human Rights Watch*, 16 Mar. 2017, https://www.hrw.org/news/2017/03/16/politics-arsenic-free-water.
- "Mindfulness, Awareness and Pastoral Support." *Change For Good*, 20 Mar. 2020, http://blog.westminster.ac.uk/changeforgood/2020/03/mindulness-awareness-and-pastoral-support/ .
- "Natural Resources Conservation Service." *Soil Texture Calculator | NRCS Soils*, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167 .
- Saklaine, Mohammad. "Human Major Organ Systems." *EduGonist*, 11 Sept. 2021, https://www.edugonist.com/human-major-organ-systems/
- "What Is Biochar?" *The European Biochar Industry Consortium*, https://www.biochar-industry.com/biochar/.
- Whitworth, Kerry. "Acid Mine Drainage from the Dabaoshan Mine in Guangdong, China ." *Alamy*, https://www.alamy.com/stock-photo-acid-mine-drainage-from-the-dabaoshan-mine-in-guangdong-china-79458523.html .